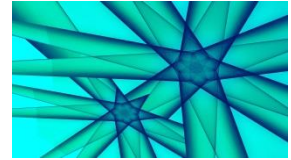




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# **Cardiovascular risk mapping in the Netherlands and Australia: a comparative analysis**

**2014 APHCRI / Radboudumc  
International Visiting  
Fellowship Report**

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## Acronyms

ABS	Australian Bureau of Statistics
BMI	Body Mass Index
CVD	Cardiovascular Disease
FRE	Framingham Risk Equation
GP	General Practitioner
HDL	Hyper Density Lipoprotein
IDW	Inverse Distance Weighting
LVH	Left Ventricular Hypertrophy
PHC	Primary Health Care
Radboudumc	Radboud University Medical Centre
SA1	Statistical Area level 1
SBP	Systolic Blood Pressure
TC	Total Cholesterol
CBS	Dutch Central of Bureau of Statistics

## Fellowship summary

Lifestyle-related chronic illnesses (such as diabetes mellitus and cardiovascular disease (CVD)) are predicted to rise alarmingly in Australia and worldwide over the next few decades, posing challenges that will need to be met by effective preventive medicine strategies and primary health care services planning. Chronic disease risk analysis is a key area of interest for APHCRI and the Radboudumc Department of Primary and Community Care, Nijmegen, The Netherlands.

The Radboudumc Department of Primary and Community Care is a well-known and active research Centre analysing large, longitudinal primary health care and chronic disease data in the Netherlands. This visiting fellowship provided a unique opportunity for me to build international research relationships and collaborations in primary health care research. It also enhanced my international profile as well as that of the National Centre for Geographic and Resource Analysis in Primary Health Care (GRAPHIC), a spatial modelling service to support policy relevant research in primary health care and build research capacity for PHC.

This opportunity had a great impact on translating evidence-based research findings into the development of policy to enable geographic targeting of preventive interventions. The APHCRI/ Radboud University Medical Centre visiting fellowship also provided an opportunity to access international primary health care data and allowed me to undertake a comparative study of geospatial analysis of cardiovascular risk. This was an important opportunity to develop my leadership in chronic disease risk mapping and gain further knowledge in the area of chronic diseases risk assessment and innovations in primary health care methods. The finding could help preventive interventions to be targeted in the right place, at the right time, to the right people. It also provides an innovative tool to help address the alarming rise of CVD in the Australian and Dutch communities.

## BACKGROUND

CVD is a leading cause of death and disease burden across the world, and the burden is expected to increase as the population ages (1–3). CVD is the most expensive disease in Australia; it accounted for \$7.9 billion, or 11%, of health spending from 2009 to 2010 (1).

The most commonly used CVD risk prediction algorithms are those derived from the Framingham Risk Equation (FRE), which is used in general practice (GP) to assess risks for individual patients (4). The trend in primary prevention of CVD in GPs has been to move away from assessment of relative CVD risk factors toward assessment and management of these factors as absolute CVD risk (5, 6).

Best-value prevention strategies require knowledge and contextualised understanding of people, communities, and environments, as well as variations in CVD risk. Although clinically proven tools are available for assessing risk factors in individuals, most at-risk individuals never take part in such assessment until disease progression is under way. Although imprecise proxies for risk can be used to make community-based risk estimates, there is still a considerable knowledge gap; no fine-grained population tools exist to directly predict 'hotspots' for future CVD risk from GP clinical data.

Few studies have attempted to examine spatial variation of CVD risk at a smaller geographic scale across the world. Noble et al examined the feasibility of mapping chronic disease risk in general and created a small-area map of diabetes risk from GP clinical records in the United Kingdom (7). In Australia, Tideman et al compared the CVD risk of a population survey sample from northwest Adelaide with a nearby rural population but did not look at the variation within the survey population catchment area (8). This is the first study that visualises the pattern of CVD risk at a small-area scale from GP clinical records to explore

possible clusters or hotspots of CVD risk in Dutch and Australian communities. The small area used, Statistical Area Level 1 (SA1), has a population size between 200 to 800 people, which is approximately equal to the size of a US census block (315 people on average) (9).

The main objective of this study was to explore patterns of CVD risk in people across small areas and investigate the association between area-level socioeconomic and lifestyle status and CVD risk patterns in the Netherlands and Australia. This approach allows the production of fine-grained maps of CVD risk for use by clinicians and policy makers to enable geographic targeting of interventions in communities.

## Methods

### STUDY AREAS AND DATA SOURCES

De-identified clinical practice data from 2012 through 2014 were drawn from Adelaide city (west) in Australia and Nijmegen City in the Netherlands (see figure 1 and figure 2). The data were linked to the four-digit postcodes in the Netherlands (see figure 3) and SA1s in Australia (see figure 4) using methods described by Mazumdar et al in 2014 (10). Overall, data on 19,000 active patients aged 30 to 74 were extracted from 16 practices in west Adelaide. The sample size from GP practices in Nijmegen was 9,000. These active patients had no prior history of CVD (i.e., stroke, chronic heart disease, peripheral vascular disease, or heart failure).

Patients were excluded if data were not available for seven risk factors (Table 1) for CVD, which are required to calculate the FRE. A major part of the analysis was based on geography, so the patients were classified according to the SA1 in which they resided. To maintain confidentiality, the study excluded those SA1s that contained fewer than five patients, leaving a sample of 18,835 patients. Under Australian health care, patients access primary health care as the point of entry into the health care system, and each year approximately 85% of the population has contact with a GP. Therefore, to the degree that GPs choose to participate in studies such as these 16 practices, it is possible to obtain high patient coverage.



Figure1: the Netherlands and Nijmegen city

Source: Google online maps,

[https://www.google.com.au/search?q=The+Netherlands+maps&espv=2&biw=1065&bih=707&tbm=isch&imgil=Jira9V6Sd7bU6M%253A%253BoVv-9uW0ivl4aM%253Bhttp%25253A%25252F%25252Fwww.internationalstudents.nl%25252Fmaps-of-the-netherlands%25252F&source=iu&pf=m&fir=Jira9V6Sd7bU6M%253A%252CoVv-9uW0ivl4aM%252C\\_&usq=\\_cBaG1dnGgkGtTrWcYSztArNwt8w%3D&ved=0ahUKEwi2sKjhme7JAhUBGqYKHXByB\\_0QyjcIKg&ei=7Jd4VraKFYG0mAXw5J3oDw#imgsrc=e\\_9pgntR2nGyXM%3A&usq=\\_cBaG1dnGgkGtTrWcYSztArNwt8w%3D](https://www.google.com.au/search?q=The+Netherlands+maps&espv=2&biw=1065&bih=707&tbm=isch&imgil=Jira9V6Sd7bU6M%253A%253BoVv-9uW0ivl4aM%253Bhttp%25253A%25252F%25252Fwww.internationalstudents.nl%25252Fmaps-of-the-netherlands%25252F&source=iu&pf=m&fir=Jira9V6Sd7bU6M%253A%252CoVv-9uW0ivl4aM%252C_&usq=_cBaG1dnGgkGtTrWcYSztArNwt8w%3D&ved=0ahUKEwi2sKjhme7JAhUBGqYKHXByB_0QyjcIKg&ei=7Jd4VraKFYG0mAXw5J3oDw#imgsrc=e_9pgntR2nGyXM%3A&usq=_cBaG1dnGgkGtTrWcYSztArNwt8w%3D)



Figure 2: Australia and Adelaide city

Source: [www.freeworldmaps.net](http://www.freeworldmaps.net)

## CHARACTERISTICS ASSOCIATED WITH CVD RISK AND IDENTIFYING AREAS OF HIGH RISK

We used the FRE to evaluate 5-year and 10-year absolute risks of CVD for individuals based on GP clinical data for the west Adelaide area and Nijmegen city. The FRE, a risk model designed for use on individuals' clinical data, is well-suited for producing population-level risk estimates (11, 12). The FRE accounts for age, sex, total cholesterol, high-density lipoprotein cholesterol, systolic blood pressure, smoking status, and whether a patient has diabetes, to estimate the patient's risk for developing CVD in the next 10 years (see Table 1). The recommended scoring system has been in use since 1991 (13). We also calculated patients' 5-year risk of CVD using the FRE and compared these data with the 10-year data to assess patterns.



*Table 1: Estimated CVD risk score and corresponding risk factors*

n.	Gender	Age	SBP	Smoking	TC	HDL	Diabetes	LVH	10Y CVD risk (%)
1.	F	63	139	0	5.7	2.5	0	0	8
2.	M	70	162	0	4.4	1	1	0	48
3.	F	60	151	0	3.5	1.9	1	0	16
4.	M	73	140	0	3.3	1.2	1	0	33
5.	M	71	136	0	4.5	1.71	1	0	29
6.	M	44	150	0	6.2	1.3	0	0	10
7.	M	56	138	1	4.6	1	0	0	28
8.	M	68	153	0	4.8	1.5	0	0	26
9.	F	66	160	1	3.7	2.2	0	0	18
10.	F	55	155	1	7.2	1.5	0	0	25

The National Vascular Disease Prevention Alliance in Australia defined CVD risk category on the basis of FRE as follows: an absolute risk of CVD events over 10 years higher than 20% is high risk; from 10% to 20% is moderate risk, and less than 10% is low risk. Body Mass Index (BMI, kg/m<sup>2</sup>) was not used in the FRE, but because it is a major risk factor for CVD we included the distribution of CVD risk by BMI category. We used World Health Organization recommendations for BMI cut-offs as follows: underweight, less than 18.5; normal weight, 18.5 to 24.9; overweight 25.0 to 29.9; and obese, 30.0 or higher.

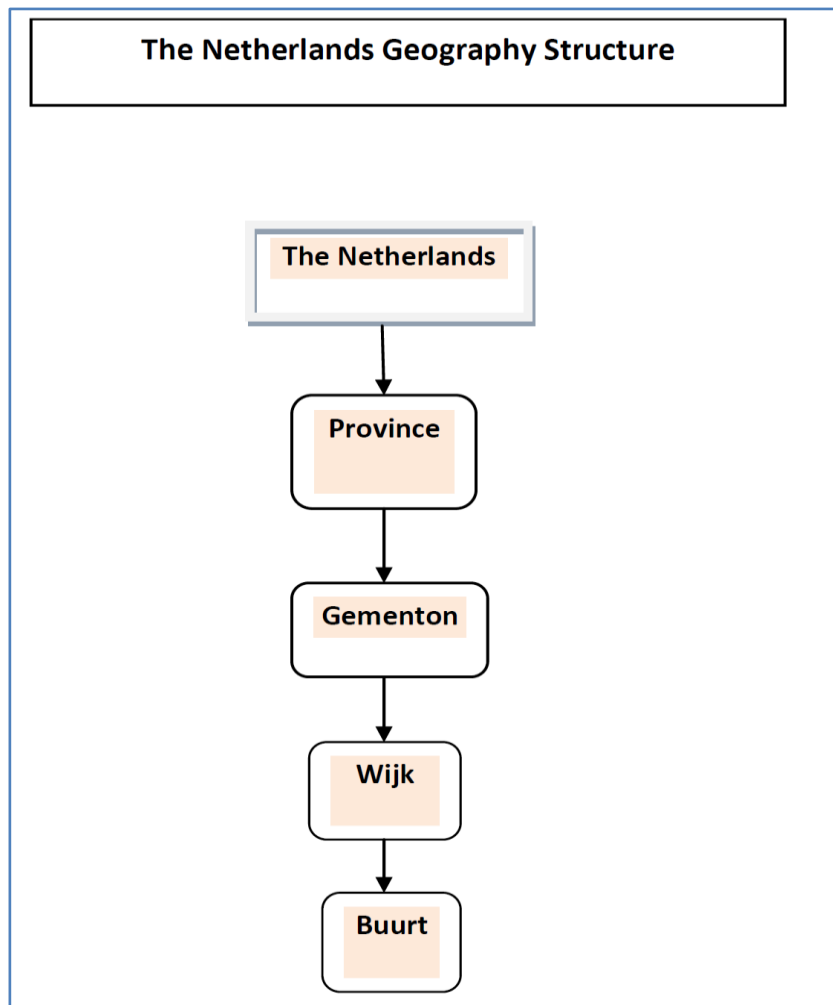
To calculate area/ community level of CVD risk, we first linked the de-identified patient records, including calculated absolute 5-year and 10-year CVD risk, to the corresponding SA1s and the 4-digit postcodes in west Adelaide and Nijmegen respectively. Second, the individual risk scores were aggregated to SA1 and postcode level by calculating mean risk for each SA1 and postcode (see Table 2). Third, the area level of CVD risk was visualised to examine the areas of high and low probability of developing CVD risk over the next 10 years in the study area.

*Table 2: Calculating areas level of CVD risk*

Patient ID	Ind. CVD risk	SA /postcode ID	SA CVD risk
10	5%	2011213	6%
50	10%	2011213	6%
111	3%	2011213	6%
30	16%	3001400	12%
110	8%	3001400	12%

SA = South Australia

An index of relative socioeconomic disadvantage (IRSD) developed by the Australian Bureau of Statistics was linked to the corresponding SA1 to make comparisons with the pattern of absolute CVD risk (14, 15). IRSD is a general socioeconomic index derived from census variables related to disadvantage, such as low income, low educational attainment, unemployment, and dwellings without motor vehicles. We ran a linear regression model to investigate the relationship between CVD risk and IRSD, adjusting for demographic variables.



*Figure 3: Geography scale in the Netherlands (left)*

*Source: Author adapted using Dutch Central Bureau of Statistics (CBS)*

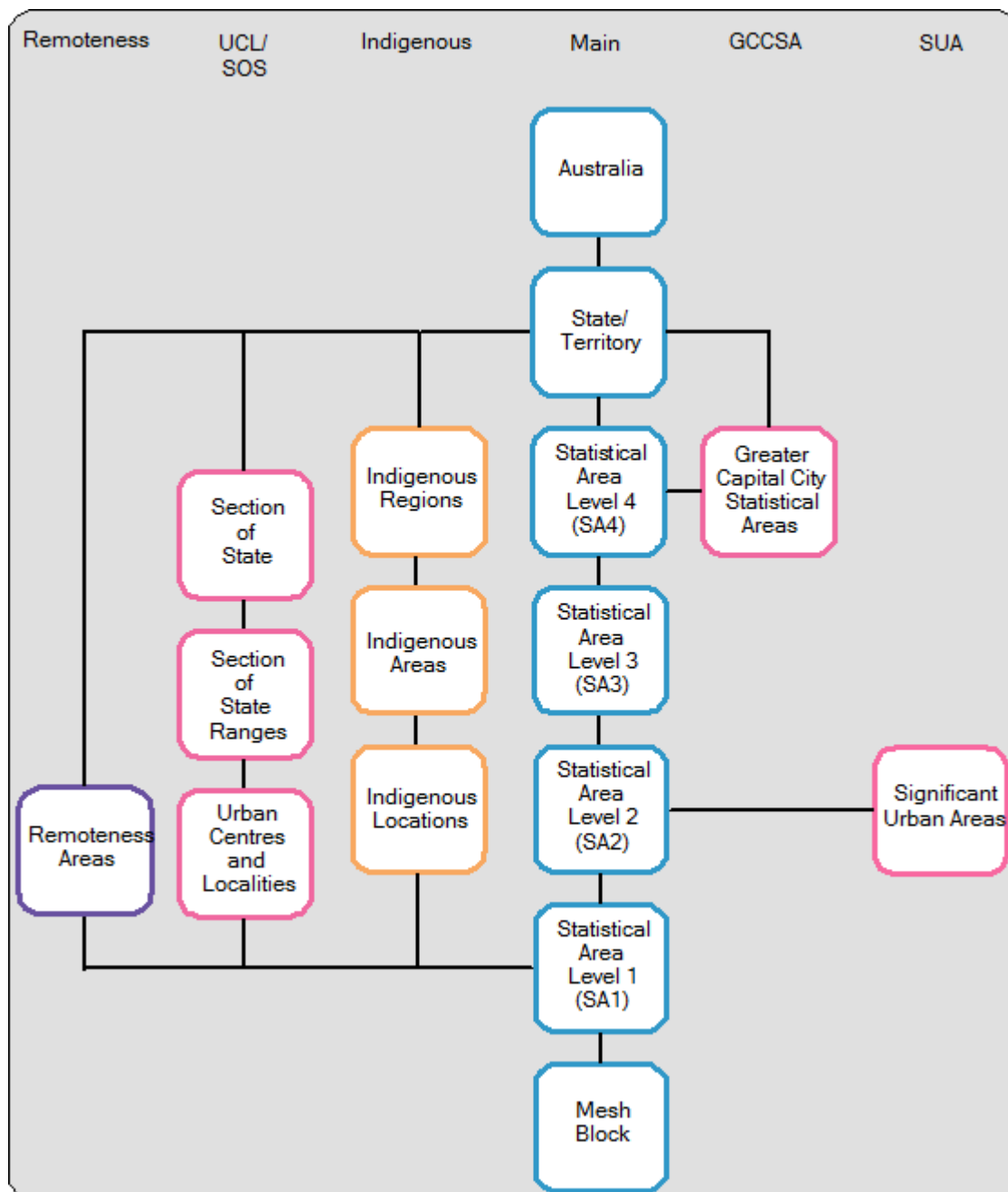


Figure 4: The Australian Statistical Geography Standards (ASGS) 2011 structure

Source: Australian Bureau of Statistics

To identify areas with high risk (hotspots) and low risk (coldspots) for CVD, a continuous heat map of CVD risk was generated using hotspots analyses. Furthermore, the tertile of the index of relative socioeconomic disadvantage was mapped for each SA1 to compare with the pattern of CVD risk at the SA1 level in west Adelaide (11). Tertile is any of the two points that divide an ordered distribution into three parts, each containing a third of the population. However, in the Netherlands we obtained the self-reported lifestyle data at the postcode level from the Department of Public Health in Nijmegen to examine their association with CVD risk patterns. These lifestyle data include smoking, level of physical activity, vegetable consumption, alcohol consumption and financial difficulties.

We used Stata version 12.1 (StataCorp, LP) to calculate the CVD risk scores and conduct descriptive analyses for our sample population and ArcGIS version 10.2 (Esri) to conduct spatial analyses and mapping. The study obtained ethics approval from the Australian National University human ethics committee (protocol 2014/174).

## Results

A journal paper from the international visiting fellowship is under preparation and detailed study results will be available in the publication. Authors will submit the paper to the British Medical Journal in the first instance.

The research finding showed that CVD risk is higher in area with socioeconomic level. Additionally people living in neighbourhoods with higher density of public green spaces had lower risk of CVD. Figure 3 shows two different neighbourhoods with different CVD risk score in that two left hand side photos are representing areas with low CVD risk and two right hand side photos indicating areas with high risk.

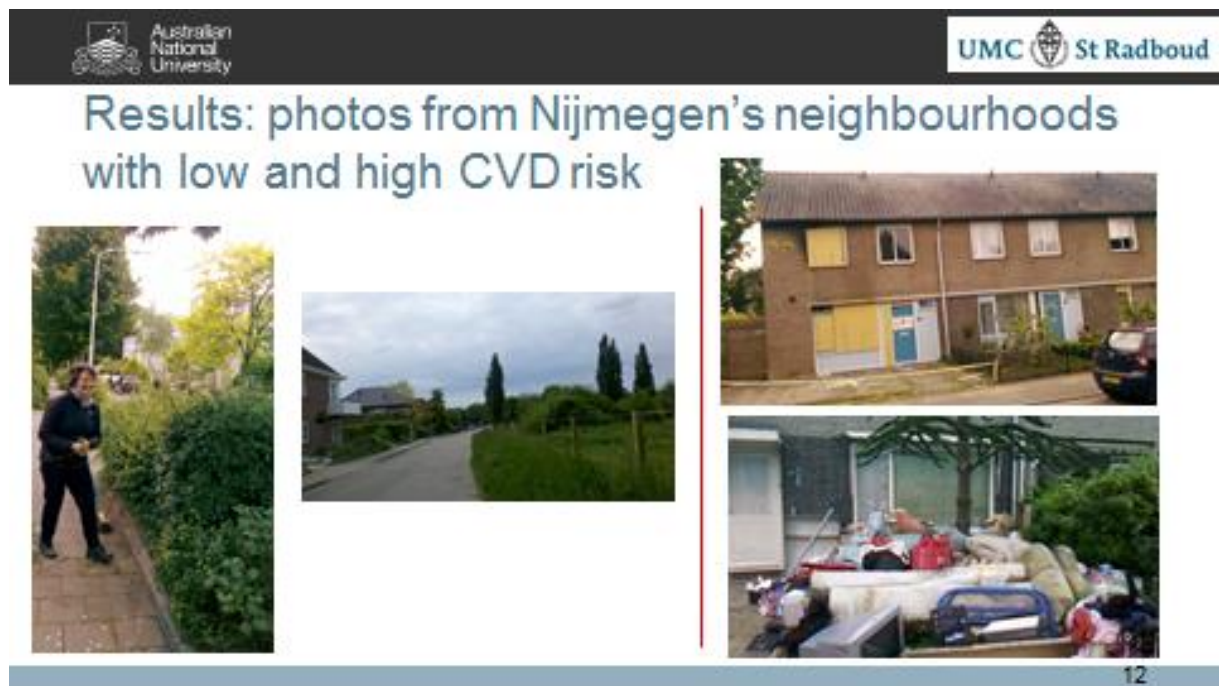


Figure 3: Neighbourhood with low CVD risk (two left hand side photos) and high risk (two right hand side photos)

Source: Author

## FURTHER ACHIEVEMENTS AND ACTIVITIES DURING THE INTERNATIONAL VISITING FELLOWSHIP

- > Two invited talks at Mashhad University of Medical Science and the Department of Khorasan Razavi Public Health, Iran
- > Three presentations at the Radboudumc, the Department of Public Health (GGD) and the Department of Primary and Health Care in Nijmegen
- > Two invited talks at the University of Saskatchewan and the Department of Reginal Public Health in Saskatoon, Canada.

## Discussion

This approach provides an opportunity for researchers who have access to GP-based clinical data to further explore prevalence, location, and correlates of CVD and is applicable anywhere that these data are available. This method can be used as a tool to identify areas of high levels of unmet need for cardiovascular care, which could enable geographic targeting of effective interventions for enhancing early and timely detection and management of CVD in those communities. Furthermore, this study demonstrates that GP data can help identify public health priorities.

This research aimed to identify area-level CVD risk and the proportion of the population at high risk using GP clinical records. Patients' 5- and 10-year risk scores were generated on the basis of the Framingham risk prediction model, and these estimated scores were aggregated and visualised at the SA1 level. Finally a 'heat map' interpolation surface of CVD risk was created to highlight the hotspots (high-risk areas) and coldspots (low-risk areas) in the study area. To our knowledge this is the first time area-level CVD risk, hotspots, and clustering in CVD risk have been studied using de-identified GP clinical records. We found that the proportion of patients at high risk for CVD risk was significantly higher in the communities of low socioeconomic status than in those of high socioeconomic status.

A considerable amount of literature has been published on the validity and generalisability of the FRE, which has been recommended as the most reliable method of predicting CVD risk in the United States (18–20). Many studies have demonstrated that the Framingham method of predicting risk is accurate when used on other populations, including most Australians and Dutch people (21–23). However, it is not generalisable to every population, and it can significantly underestimate the CVD risk of Aborigines (24). The Aboriginal data were poorly recorded in our GP dataset, so we were not able to evaluate a CVD risk pattern in Aboriginal people. However, the proportion of Aboriginal and Torres Strait Islander people in the general population in our study area was approximately 2%. Regardless of its limitations, the FRE is recommended by the National Heart Foundation of Australia to calculate CVD risk of Australians (25).

This research addressed a significant public health problem, that of identifying the spatial distribution of CVD risk in Australia in a timely way so that prevention services can be more efficiently distributed. This project also allows risk profiles to be considered in relation to socioeconomic characteristics of areas. Consequently, our approach may be useful in describing and exploring spatial inequalities in the distribution of CVD risk, or any chronic disease for which risk modelling is available, that contributes to our understanding of health inequalities.

The development of a tool for monitoring disease risk has the potential to improve service delivery, policy development, research, and ultimately health outcomes, which would be particularly beneficial for people living in underserved areas. No tools exist in Australia to predict risk hotspots in a timely manner, which means that development of chronic disease prevention policies at the national, state, and local levels are not informed by the most current information about disease risk in specific populations. Additionally, this method enables ecological studies of relationship between the area risk and socioeconomic status and built environment characteristics such as access to green spaces and fast-food outlets. This method can be used to estimate prevalence of CVD risk at different geographical scales from GP catchments to the national level, using demographic and clinical risk factors.

A limitation of this study is that the FRE may underestimate risk for people who take lipid-lowering or antihypertensive medication or people who have recently stopped smoking (29). However, current clinical practice is to calculate people's risk even if they are taking medications (30).

## Conclusion

This approach provides an opportunity for researchers who have access to GP-based clinical data to further explore prevalence, location, and correlates of CVD and is applicable anywhere that these data are available. This method can be used as a tool to identify areas of high levels of unmet need for cardiovascular care, which could enable geographic targeting of effective interventions for enhancing early and timely detection and management of CVD in those communities. Furthermore, this study demonstrates that GP data can help identify public health priorities.

## POLICY RECOMMENDATIONS

The research suggested that policy makers could focus on four domains/options in terms of CVD risk reduction activities and play a vital role in reducing CVD burden in the communities; (1) enhancing GP practice clinical data quality with collaboration of GPs and practices and making use of this unique and valuable dataset; (2) individual CVD risk profile to identify people with higher risk of CVD in communities; (3) neighbourhood/community CVD risk profile to high areas with higher rate of CVD risk, and (4) improve population lifestyle in order to mitigate CVD risk and provide high life expectancy for all.

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